

New and revised descriptions of the immature stages of some butterflies in Sri Lanka and their larval food plants (Lepidoptera: Papilionidae)

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Abstract. The immature stages and larval food plants of 13 of the 15 species of butterflies of the family Papilionidae, subfamily Papilioninae in Sri Lanka are presented. The immature stages and larval food plants of two species remain unknown. The immature stages of one species in Sri Lanka is reported for the first time. The larval food plant of another species in Sri Lanka is documented for the first time. The immature stages of the remaining 12 species that have been previously described from Sri Lankan material are compared to the findings of the current study and additional observations are presented. For these 12 species, new larval food plants are reported for the first time. For 7 of these 12 species, larval food plants previously reported in Sri Lanka are confirmed. This study provides the basic information for further studies on the biology of these species. It also provides information for conservation management programs for butterflies in Sri Lanka.

Keywords: Immature stages, larval food plants, Sri Lanka, Ceylon, Papilionidae, Lepidoptera, butterflies, conservation.

INTRODUCTION

In the current study (conducted from 2004 to the present and ongoing), we have documented the immature stages and larval food plants of 162 of the 245 known species of butterflies in Sri Lanka. For more details on the background and approach, see van der Poorten and van der Poorten (2011). In this paper, we present the immature stages and larval food plants of 13 of the 15 species of the family Papilionidae. The immature stages and larval food plants of two species remain unknown. The immature stages of 12 species covered here have been previously described from Sri Lankan material, though most of the descriptions are very brief and are only of the final instar of the larva and the pupa. These older descriptions are compared to the findings of the current study and additional observations are presented. For 12 species, new larval

food plants are reported for the first time, while for 7 species larval food plants previously reported in Sri Lanka are confirmed. Where information on the duration of developmental stages is given, these data were obtained in rearings at ambient temperatures (25–31°C) at Bandarakeswatta (07.37.01N, 80.10.57E), 70 m asl, North Western Province, Sri Lanka. Conventions used (applied to both the larva and the pupa): Segments are numbered S1 to S14 (S1—the head; S2 to S4—the 3 segments of the thorax; S5 to S14—the 10 segments of the abdomen).

RESULTS AND DISCUSSION

Tribe Leptocircini

Graphium nomius nomius (Esper, 1799). Spot Swordtail.

The immature stages of *G. n. nomius* have not yet been described in Sri Lanka but detailed accounts of the final instar larva and pupa of *G. nomius* based on Indian specimens were given by Davidson and Aitken (1890) and Bell (1912b). Woodhouse (1949) quoted a brief description from Talbot (1939) who quoted from Jordan (1909). In the course of this study, we have not yet found the larva or pupa of this species.

Larval food plants: There are no reports of the larval food plants in Sri Lanka though the report of *Polyalthia longifolia* (Annonaceae) by Jordan (1909)

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may have been based on information from Sri Lanka. In India, Bell (1912b) reported *Saccopetalum tomentosum* [now *Miliusa tomentosa*] (Annonaceae) for *G. nomius*.

Miliusa tomentosa is very local in dry forests around Bibile on the eastern side of the island. *Polyalthia longifolia* is also found on the eastern side of the island but is more widespread, especially along rivers, in dry forests. The columnar form of *P. longifolia* is also planted widely around the island, including the wet zone, as an ornamental (Dassanayake, 1985).

G. n. nomius occurs on the eastern side of the island, as far north as Trincomalee and Kantalai, south to Monaragala, Wellawaya, Wasgamuwa, Udawalawe, Kataragama and Yala, and as far west as Ritigala, and Kumbukgolla near Dambulla. It is seasonally common.

It is likely that *M. tomentosa* and/or *P. longifolia* are larval food plants. It is also likely that other species of *Miliusa* and *Polyalthia* are used because the distributions of *M. tomentosa* and *P. longifolia* do not fully cover that of the butterfly.

Graphium antiphates ceylonicus (Eimer, 1889). Fivebar Swordtail. Endemic subspecies.

The immature stages of *G. antiphates ceylonicus* have not yet been described in Sri Lanka but detailed accounts of the final instar larva and pupa of *G. antiphates* based on Indian specimens were given by Davidson *et al.*, (1897, later quoted in Woodhouse 1949) and by Bell (1912b). In the course of this study, we have not yet found the larva or pupa of this species.

Larval food plants: There are no reports of larval food plants in Sri Lanka except those given by Woodhouse (1949). He listed "*Unona lawii* [now *Desmos lawii*], *U. elegans* [now *Desmos elegans*] and *U. zeylanica* [now *Desmos zeylanica*]" (Annonaceae) without references, so it is not clear whether or not these are records from Sri Lanka. While *D. elegans* and *D. zeylanica* do occur in Sri Lanka, *D. lawii* does not, though it was reported as a larval food plant of *G. a. naira* in India (Davidson *et al.*, 1897). There is one report of *G. a. ceylonicus* ovipositing on *Xylophia championii* (Annonaceae) (M. Silva, pers. comm.) but larvae have not been reared or observed on this plant.

D. elegans is locally common at the edges and in clearings in lowland dipterocarp forest to about 300 m asl especially along streams, while *D. zeylanica* is found in dipterocarp forest of the wettest parts of the lower hill country from 200–800 m asl (Dassanayake, 1985).

G. antiphates ceylonicus is rare, but there are two

disjunct populations. One is confined to the wet dipterocarp forests of the south-west (Sinharaja, Morapitiya, Kanneliya, Kottawa, and the Peak Wilderness Sanctuary). The other population occurs in the eastern half of the dry zone (Anuradhapura, Sigiriya, Wasgamuwa, and Dambulla).

It is possible that *D. elegans* or *D. zeylanica* are used as larval food plants by the populations in the forests of the south-west. However, the populations in the eastern dry zone probably use a different larval food plant as no species of *Desmos* are found there. There are, however, several other species of Annonaceae that might be used.

Note: Many current publications and websites list "*Annona lawii*" as a larval food plant for *Graphium doson* (e.g. Kunte, 2000), but *Annona lawii* is not listed in the botanical literature. The plant referred to as *Annona lawii* may well be *Unona lawii* (now *Desmos lawii*).

Graphium sarpedon teredon (C. & R. Felder, 1865). Common Bluebottle.

The final instar larva and pupa of *G. sarpedon teredon* were described very briefly by Moore (1880) from Sri Lankan material. The larva and pupa of *G. sarpedon* was described briefly by Davidson and Aitken (1890) and by Bell (1912b) who quotes from Jordan (1909) based on Indian material. *G. teredon* was described in detail by Bell (1912b) from Indian material. Woodhouse (1949) quoted from these sources and briefly from a report by Tunnard in Sri Lanka. These descriptions agree with the findings of the current study except for the following points: in *G. s. teredon*, the larva has a brown form and a green form in the 3rd (Fig. 1a, b), 4th (Fig. 1c, d) and 5th instar (Fig. 1e, g). Both forms are mottled with fine, indistinct, small cream-colored spots. The head of the brown form is a light sandy-brown with an orange patch posteriorly (Fig. 1h). The head of the green form (Fig. 1f) is as described by Bell (1912b) for *G. teredon* in India. We have recorded the green form of the pupa (Fig. 1i) but have not yet encountered the brown form as described by Tunnard (Woodhouse, 1949).

Additional notes on immature stages: Egg: white, spherical (Fig. 1j). 1st instar: newly emerged larva ate eggshell, abdomen dark smoky green, khaki green filaments on S3, S4 and S14 (Fig. 1k). Length of mature larva 35 mm. Duration of immature stages (days): Egg (3–4); 1st instar (1–3); 2nd (3); 3rd (4); 4th & 5th (not recorded); pupation (1); pupa (12–15); egg–adult (32–39).

Larval food plants: In Sri Lanka, Moore (1880) reported "*Cinnamomeum [sic]*" [*Cinnamomum*], and Tunnard (Woodhouse, 1949) reported "several, those bearing aromatic leaves being favored, such as wild cinnamon, etc." Woodhouse (1949) also reported

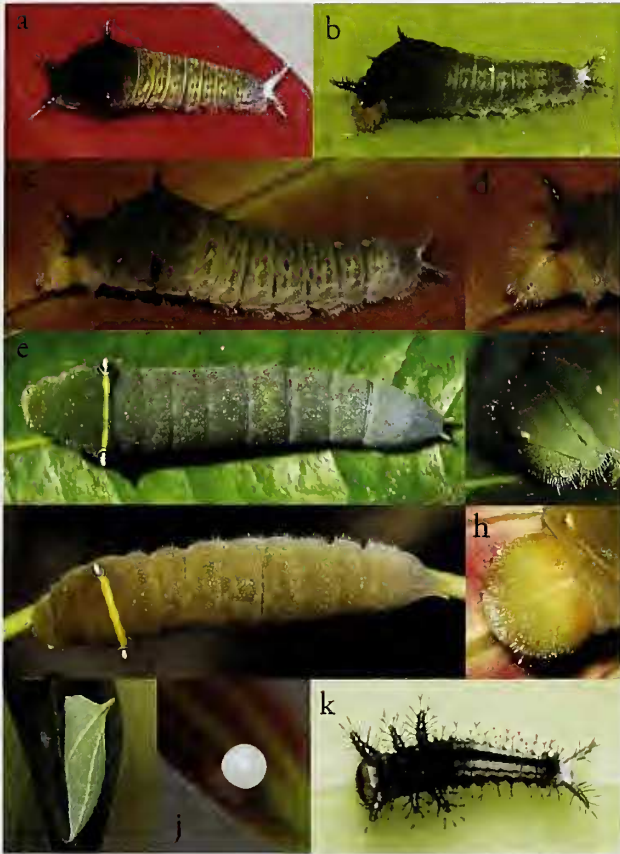


Figure 1. *Graphium sarpedon teredon*. **1a:** Larva, third instar, brown form. **1b:** Larva, third instar, green form. **1c:** Larva, fourth instar, brown form. **1d:** Larva, fourth instar, brown form, close up of head. **1e:** Larva, fifth instar, green form. **1f:** Larva, fifth instar, green form, close up of head. **1g:** Larva, fifth instar, brown form. **1h:** Larva, fifth instar, brown form, close up of head. **1i:** Pupa, green form. **1j:** Egg. **1k:** Larva, first instar.

“*Machilus odoratissima* [now *Persea odoratissima*], *Cinnamomum*, *Alseodaphne semecarpifolia*, *Litsea sebifera* [now *Litsea glutinosa*], and especially *Camphora officinalis* [now *Cinnamomum camphora*] where this tree has been imported” from Indian reports in Talbot (1939). The current study showed for the first time that the following are larval food plants in Sri Lanka: *Cinnamomum verum*, *C. capparum-coronde*, *C. dubium*, *Neolitsea cassia* and *N. fuscata* (Lauraceae). We have not been able to confirm whether or not *Litsea glutinosa* is used—if it is, it is likely to have been reported because it is a common plant. We have not been able to confirm whether or not *Cinnamomum camphora* (which is an introduced plant in Sri Lanka as well) or *Alseodaphne semecarpifolia* are used. “Wild cinnamon” may refer to *Neolitsea cassia*.

Cinnamomum species are widely distributed in Sri

Lanka especially in the moist lowlands and central hills: *C. verum* is found in the wet low country to 700 m asl; *C. dubium* is found in the wet country to 1800 m asl; *C. capparum-coronde* is common in the wet hills from 400–1400 m asl. There are no *Cinnamomum* species in the dry zone. *Neolitsea cassia* is found in the wet lowlands of the southwest and also in the hills of the intermediate zone (including Ritigala). *Neolitsea fuscata* is very common in the upper montane zone (Nuwara Eliya, Horton Plains). *Persea odoratissima* is not found in Sri Lanka; the only species of *Persea* found in the island is *P. macrantha* which is found in the wet zone from 200–1000 m asl.

G. sarpedon teredon is a common butterfly in the wet zone (the central hills and the south-west) but smaller populations are also found in the mountain ranges of the intermediate and dry zones (e.g. Ritigala).

The distributions of the known larval food plants match that of *G. sarpedon teredon* except for the populations in the mountain ranges of the intermediate and dry zones. In these areas, other species of *Neolitsea* may be used (there are no *Cinnamomum* species in these areas). It is likely that other members of the Lauraceae (including possibly *P. macrantha*) are eaten as well.

Graphium doson doson (C. & R. Felder, 1864). Common Jay. Endemic subspecies.

The immature stages of *G. d. doson* have not been described from Sri Lankan material. However, the final instar larva and pupa of *G. doson* were described briefly by Davidson and Aitken (1890) and by Talbot (1939, after Jordan 1909) and in detail by Bell (1912b) from Indian material. Woodhouse (1949) quoted from these sources. These descriptions of the larva agree with the findings of the current study except for the following points: Davidson and Aitken (1890) described the larva as black or smoky in the first four instars. In the current study, *G. d. doson* is a dull chocolate brown in the 2nd instar (Fig. 2a); a darker chocolate brown in the 3rd instar (Fig. 2b); light cinnamon brown (Fig. 2c) or dark chocolate brown in the 4th instar; and green (Fig. 2d) or smoky purplish-brown (Fig. 2e) in the 5th instar. Bell (1912b) described the larva as “black in the early stages with tail points of pure white.” In the current study, the 2nd instar of *G. d. doson* has S14 white and the tail points brown; the amount of white on S14 decreases with each subsequent instar until the 5th when S14 is mostly green or smoky purplish-brown. The historical descriptions of the pupa agree with the findings of the current study (Fig. 2f).

Additional notes on immature stages: Egg: globular, smooth, pale bluish-white when laid, soon turning pale yellow (Fig. 2g).



Figure 2. *Graphium doson doson*. 2a: Larva, second instar. 2b: Larva, third instar. 2c: Larva, fourth instar. 2d: Larva, fifth instar, green form. 2e: Larva, fifth instar, smoky purplish-brown form. 2f: Pupa, lateral view. 2g: egg.

Duration of immature stages (days): Egg (4–5); 1st instar (1); 2nd (2); 3rd (2); 4th (7); 5th (6); pupa (12).

Larval food plants: In Sri Lanka, Woodhouse (1949) reported “*Cinnamomum*, *Polyalthia* and other Annonaceae” (likely after Talbot 1939). The current study showed for the first time that the following are larval food plants in Sri Lanka: *Polyalthia cerasoides* (H. D. Jayasinghe, pers. comm.), *Polyalthia korinti*; and, in the lab, the larvae ate the tender leaves and flowers of *Miliusa indica* (Annonaceae). We have not observed any species of *Cinnamomum* being used as a larval food plant in Sri Lanka.

Polyalthia cerasoides is locally abundant in dry forests of the east, south-east and south. *Polyalthia korinti* is widespread and common in the dry and wet zones to 300 m asl. *Miliusa indica* is widespread from sea level to 1000 m asl in the dry, intermediate and wet zones (Dassanayake, 1985).

G. d. doson is widely distributed over the whole island, except in north, and is seasonally very

common. Though the distribution of the known larval food plants matches the distribution of *G. d. doson*, it is likely that there are other larval food plants as the ones identified so far are not that common as to account for all breeding populations.

Graphium agamemnon menides (Fruhstorfer, 1904). Tailed Jay.

The final instar larva and pupa of *G. agamemnon menides* were described very briefly by Moore (1880) from Sri Lankan material. The larva and pupa of *G. agamemnon* were described briefly by Davidson and Aitken (1890), in detail (all instars) by Bell (1912b) and briefly by Talbot (1939) based on Jordan (1909) from Indian material. Woodhouse (1949) quoted from these sources and also reported details of the egg and all instars from Tunnard using Sri Lankan material. These descriptions agree with the findings of the current study except for the following points: Bell (1912b) reported a white doubled subspiracular line. In the current study, in *G. a. menides*, the subspiracular line is often absent; if present, it is not distinct and consists of two dark-colored bands with a lighter band in-between (bands the same color as the ground color). Two forms are found in the final instar: green (Fig. 3a), and ochre-yellow with a greenish tinge (Fig. 3b) in agreement with Talbot (1939, after Jordan, 1909). The description of the 1st instar agrees with that of Tunnard rather than that of Jordan.

Additional notes on immature stages: Egg: pale yellow when first laid, later turning orangish with blotches (Fig. 3c). 1st instar: dark brown when newly hatched; turns greenish-brown the next day (Fig. 3d). 2nd instar: ground color varies from dark green (Fig. 3e) to almost black (Fig. 3f). 3rd instar: ground color varies from olive green (Fig. 3g) to greenish-brown. 4th instar: ground color varies from grayish-green (Fig. 3h) to brownish-green. Pupa: the green form (Fig. 3i) seems to be the most common as we have not yet observed the brown form reported by Tunnard. Duration of immature stages (days): Hatching to pupation (20–21); pupation (1); pupa (10–12).

Larval food plants: In Sri Lanka, Moore (1880) reported “Magnoliaceae and Anonaceae [sic]” and, after Mackwood, “Soursop [*Annona muricata*] and Cinnamon.” Woodhouse (1949) reported various Annonaceae as reported from Indian sources as well as *Annona cherimola* reported by Tunnard from Sri Lankan material. The current study showed for the first time that the following are larval food plants in Sri Lanka: *Persea americana* (N. Kamalgoda, pers. comm.), *Polyalthia cerasoides* (H. D. Jayasinghe, pers. comm.), *Annona squamosa*, *A. reticulata*, *A. glabra*, *Polyalthia suberosa*, *Uvaria macropoda*, *U. sphenocarpa*, *Artabotrys hexapetalus*, *Miliusa indica* and *M. tomentosa* (Annonaceae) and *Michelia champaca* (Magnoliaceae). The current study also confirmed that *Annona muricata* is a larval food



Figure 3. *Graphium agagemnon menides*. 3a: Larva, fifth instar, green form. 3b: Larva, fifth instar, ochre-yellow with a greenish tinge form. 3c: Ova. 3d: Larva, first instar, newly hatched. 3e: Larva, second instar, dark green form. 3f: Larva, second instar, black form. 3g: Larva, third instar, olive green form. 3h: Larva, fourth instar, grayish-green form. 3i: Pupa, green form.

plant in Sri Lanka. We have not been able to verify the use of *A. cherimola* but Tunnard is undoubtedly correct in his identification. We have not been able to verify that any species of *Cinnamomum* ("Cinnamon", Lauraceae) are used as a larval food plant.

Persea americana, *Annona reticulata*, *A. muricata* and *Michelia champaca* are cultivated plants that are commonly grown in the low and mid-country wet and intermediate zones. *A. glabra* is abundant and naturalized along the south-west coast. *A. squamosa* is naturalized and cultivated in the northern part of the dry zone. *Polyalthia suberosa* is locally common, especially near the coasts, in the dry and wet zones. *P. cerasoides* is locally abundant in dry forests, mostly in the east and southeast. *Uvaria macropoda* is widely distributed in the dry and intermediate zone but is not found in the lowlands of the south-west. *U. sphenocarpis* an endemic plant found locally in the dry, intermediate

and wet zones up to about 700 m asl in disturbed forests. *Artabotrys hexapetalus* is uncommon in the forests of the dry zone. *Miliusa indica* is widespread from sea level to 1000 m asl in the dry, intermediate and wet zones (Dassanayake, 1985, 1987).

G. agagemnon menides is common and widely distributed over the whole island except for the north. Though the distributions of the known larval food plants match that of *G. agagemnon menides*, it is likely that other species of Annonaceae are used as well.

Tribe Troidini

Pachliopta jophon Gray, [1853]. Sri Lankan Rose. Endemic species.

The egg and final instar larva of *P. jophon* were described and illustrated by Green from Sri Lankan material in Moore (1884-1887). Green described the egg as "tawny, globular, ridged." In the current study, the egg is pink and smooth but overlaid with a rough, ridged, discontinuous orange coating (Fig. 4a). Since Green's drawing and description account for only 13 segments in the larva, we redescribe the thorax and abdomen of the larva: the filaments (crimson unless otherwise stated): S3–S14, 1 pair (subdorsal, white on S7); S2–S5, 1 pair (lateral); S3–S12, 1 pair (subspiracular, white on S7); S3–S12, 1 pair (below subspiracular, highly reduced in some individuals). The white band on S7 does not meet on the dorsum as it does in *P. aristolochiae ceylonica* (Figs. 4b, c). Otherwise Green's description of the larva agrees with the findings of the current study except for the following points: in *P. jophon*, a) some larvae have a white subdorsal interrupted band and extensive white markings below the subdorsal spines that run obliquely to the posterior margin of the previous segment (Figs. 4d, e); b) other individuals have white on the anterior edge of the subdorsal spines; and c) S2 has a light-orange anterior transverse band with 1 pair of subdorsal whitish protuberances, a dark purple posterior band and a black, shiny shield between (Fig. 4f). The pupa has not yet been described. In the current study, however, the few field-collected larvae were parasitized and died prior to pupation though the pupa is reported to be very similar to that of *P. Hector*.

Additional notes on immature stages: The eggs were laid singly on the branches and twigs of the larval food plant, and occasionally on a leaf. 1st instar: newly emerged larva ate the eggshell. 2nd instar: same as 5th but filaments somewhat shorter (Fig. 4g). 3rd & 4th: not recorded. Duration of immature stages (days): Egg (7).

Larval food plants: In Sri Lanka, a plant belonging "to the Aristolochiaceae family" was reported by Woodhouse (1949). The current study showed for

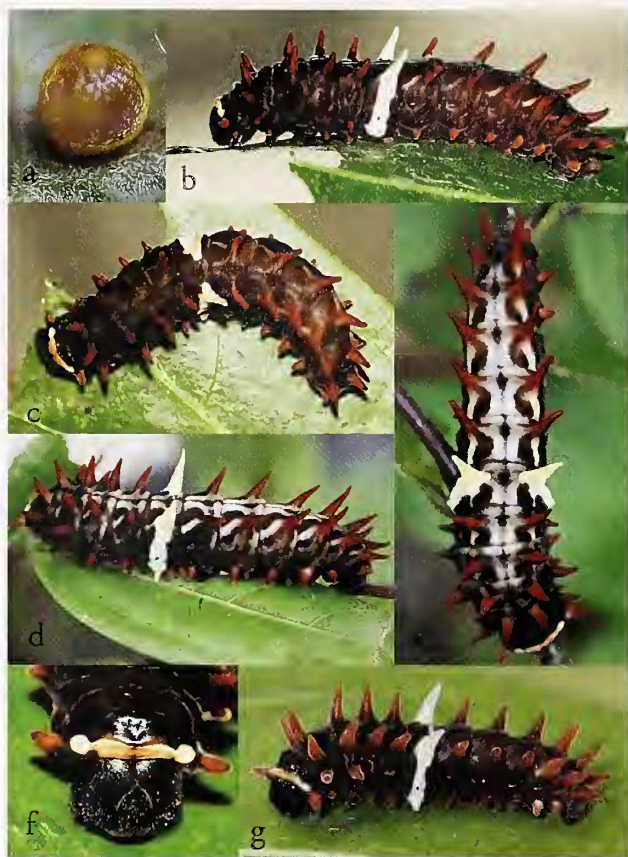


Figure 4. *Pachliopta jophon*. 4a: ova. 4b: Larva, fifth instar. 4c: Larva, fifth instar. 4d: Larva, fifth instar. 4e: Larva, fifth instar. 4f: Larva, fifth instar, close up of head and S2. 4g: Larva, second instar.

the first time that the following is a larval food plant in Sri Lanka: *Thottea siliquosa* (Aristolochiaceae). *T. siliquosa* is fairly common but found only in the wet zone where it grows under dense shade (Dassanayake, 1999).

P. jophon is a rare forest-dwelling butterfly but may appear in fair numbers during the season (May–July). Its distribution matches that of *T. siliquosa*, which is probably its only larval food plant.

Pachliopta Hector Linnaeus, 1758. Crimson Rose.

The final instar larva of *P. Hector* was described by Moore (1880) only as being “very similar” to that of *P. aristolochiae ceylonica* based on Sri Lankan material. Based on Indian material, Davidson and Aitken (1890) described the larva briefly while Bell (1911) described the larva and pupa in detail. Talbot (1939) quoted Bell (1911); Woodhouse (1949) quoted Talbot (1939). These descriptions agree with the findings of the current study except for the following points: a)

in some individuals, the filaments are dark purplish-brown and reduced in size, and the markings are highly reduced making the larva appear almost black (Fig. 5a); b) subdorsal spots on S7–S11 are variable in size and placement, and are sometimes obsolete; c) lateral spots on S8–S11 are reduced or absent; d) S7 has 1 pair of spots on the anterior margin and one pair of elongated spots on the posterior margin (Fig. 5b, c). In addition, the placement of the filaments is at variance with these descriptions so a complete description of the filaments is given here: S2–S14, 1 pair (subdorsal, S2 & S14 very short); S2–S12, 1 pair (subspiracular); S2–S5, 1 pair (lateral); S3–S12, 1 pair (below subspiracular); the filaments are slightly constricted below the apex which is bulbous.

Additional notes on immature stages: Egg: orange, smooth and globular, transversely ribbed with a rough, orange, discontinuous coating, apex slightly pointed (Fig. 5d). 1st instar: newly emerged larva ate the eggshell, abdomen light purplish-red. Next day—head reddish-brown, abdomen purplish-red, fading to reddish-orange from S11–S14, filaments (same color as body, each with several long, black spines): S2–S12, 2 pairs (subdorsal and subspiracular); S3 & S4, 1 pair (lateral); S2 with anterior and posterior light yellowish-brown transverse bands which meet at the sides, dark brown dorsally between the bands (Fig. 5e). 2nd instar: head black, filaments without spines, uniform purplish-red, S2–S13, 1 pair (subdorsal); S2–S4, 1 pair (lateral); S3–S12, 1 pair (subspiracular); S14, 1 pair (Fig. 5f). 3rd instar: head black, abdomen velvety purplish-black; filaments: S2–S13, 1 pair (subdorsal); S3–S12, 1 pair (subspiracular); S2–S4, 1 pair (lateral); S2–S4, 1 pair (spiracular), filaments same as body color except subdorsal ones on S2, S11, S12, S14 and base of S11 light orange; S2 with anterior and posterior margins elevated enclosing a black space; anterior transverse band with 1 pair of orange transverse streaks, posterior transverse band with 1 pair subdorsal filaments, pinkish-white streak on the base of filaments on S11 and S12 (Figs. 5g, h). 4th instar: similar to 3rd except with an additional spot on S7–S10, anterior to the lateral filaments (Fig. 5i). Pupa: dark purplish-brown right after pupation, later turning light pinkish-brown, broader in the first four segments than that of *P. aristolochiae ceylonica* and the lateral extensions of the arrow-shaped ridge on the dorsal surface of S4 are more pointed (Figs. 5j–l). Length of mature larva 38 mm. Duration of immature stages (days): 1st instar (2); 2nd (4); 3rd (2); 4th (3); 5th (7); pupation (2); pupa (usually 15–17, up to 104).

Larval food plants: In Sri Lanka, Moore (1880) reported “*Aristolochia*.” Woodhouse (1949) reported *Aristolochia indica* based on Talbot (1939), which was based on Bell (1911) reporting from India. The current study showed for the first time that the following are larval food plants in Sri Lanka: *Aristolochia indica* and *A. bracteolata* (Aristolochiaceae). *A. indica* is widespread over most of the island up to 1000 m asl (Dassanayake, 1999). *A. bracteolata* is restricted to dry sandy regions (Jaffna, Mannar, Trincomalee and Batticaloa). Larvae were found feeding on *A. bracteolata* on the bund of Giant’s Tank at Mannar. *A. bracteolata* grows in the open, scrambling along the ground; the larvae feeding on the plant were quite exposed.



Figure 5. *Pachliopta hector*. 5a: Fifth instar, dark individual with reduced markings. 5b: Fifth instar, dorso-lateral view. 5c: Fifth instar, dorsal view. 5d: Egg. 5e: First instar, newly emerged. 5f: Second instar. 5g: Third instar, dorsal view. 5h: Third instar, lateral view. 5i: Fourth instar, lateral view. 5j: Pupa, lateral view. 5k: Pupa, dorsal view. 5l: Pupa, ventral view, close up of head region.

P. hector is common over most of the island. Its distribution matches that of *A. indica* and *A. bracteolata* well. These are probably the only two larval food plants in Sri Lanka. However, it is possible that the larvae also feed on *A. ringens*, a naturalized introduction that is found in the central hills though there are reports that this plant is poisonous to the larva (H. D. Jayasinghe, pers. comm.). It may also feed on *Thottea siliquosa* (Aristolochiaceae), which is found in the wet zone, and which is used by *P. aristolochiae ceylonica*.

Pachliopta aristolochiae ceylonica (Moore, 1881). Common Rose. Endemic subspecies.

The final instar larva and pupa of *P. aristolochiae ceylonica* were described very briefly by Moore (1880) from Sri Lankan material. The larva and pupa of *P. aristolochiae* were described by Davidson and

Aitken (1890), Moore (1901-1903), Bell (1911) and Talbot (1939) from Indian material. Woodhouse (1949) quoted these sources and also included a brief description of the Ceylon subspecies. These descriptions agree with the findings of the current study except for the following points: in *P. a. ceylonica*, a) the band on S7 is not pale flesh-colored (as per Moore, 1880) or pinkish (as per Davidson & Aitken, 1890) but white to cream-colored, and sometimes with a sand-colored or pinkish tinge especially on the filaments; b) some individuals do not have a spot on S8 or on S11 (as per Davidson & Aitken, 1890); c) although Woodhouse (1949) used the same system of numbering as the current study, he reported that the white band was on S6 but it is on S7; and d) some individuals have 2 crimson streaks on the adfrontal area of the head. The descriptions of the filaments given by Moore are at variance with the current study and are also somewhat different from those reported by Bell; therefore we redescribe them here: S3–S14, 1 pair (subdorsal); S2–S12, 1 pair (subspiracular); S2–S4, 1 pair (lateral); S2, 1 pair (spiracular); all filaments evenly tapered to the apex (Figs. 6a, b).

Additional notes on immature stages: Egg: light pink, smooth and globular, transversely ribbed with a rough, orange, discontinuous coating, apex slightly pointed (Fig. 6c). 1st instar: newly emerged larva (Fig. 6d) ate the eggshell, head black with black spines, abdomen reddish-brown, filaments (each with numerous black spines)—S3–S13, 1 pair (subdorsal, those on S3, S4, S7, S8, S11–S13 orangish, those on S5, S6, S9, S10 dark purplish-black); S2–S12, 1 pair (subspiracular, those on S2, S3, S11, S12 orangish, those on S4–S10 purplish); S2, 1 pair (lateral, reddish-orange); and a slight white protuberance on S14; S2 with an anterior white transverse dorsal band and posterior dark brown transverse band; next day—head black, abdomen purplish-brown, filaments with numerous black spines, subdorsal filaments on S7 white, on S3 & S4 orangish, on S5 & S6 and S8–S10 purplish brown, on S11–S13 light orange, subspiracular filaments on S7 tipped with white, rest of filaments purplish brown (Fig. 6e). 2nd instar: head black, abdomen velvet purplish-black, all filaments devoid of spines, placement and number of filaments as in the 1st instar but S3 & S4 with an additional lateral pair of filaments; the white on S7 now continues in a transverse band across the dorsum and down the sides almost meeting the subspiracular filament and with a black patch laterally; S2 with an orange anterior transverse band and a purplish posterior transverse band with 2 orange lateral spots, black between the bands which meet at the lower lateral edge (Fig. 6f). 3rd instar: similar to the 2nd but all filaments are longer and of the same color (dark reddish-purple) except for S7 which is white, ground color a darker, uniform purplish-brown (Fig. 6g). 4th instar: ground color purplish-black, filaments longer than in 3rd instar, white filaments on S7 tinged with red, and white transverse band on S7 interrupted on the dorsum (Fig. 6h, i). Pupa: similar to other *Pachliopta*, but the lateral processes of the head are horizontal (Fig. 6j-l). Length of mature larva 35–40 mm. Duration of immature stages (days): Egg (5); 1st instar (2); 2nd (2); 3rd (3–4); 4th (3–4); 5th (not recorded); pupation (2); pupa (13–15).

Larval food plants: In Sri Lanka, "*Aristolochia*" was reported by Moore (1880). Woodhouse (1949) quoted "various species of *Aristolochia*" based on

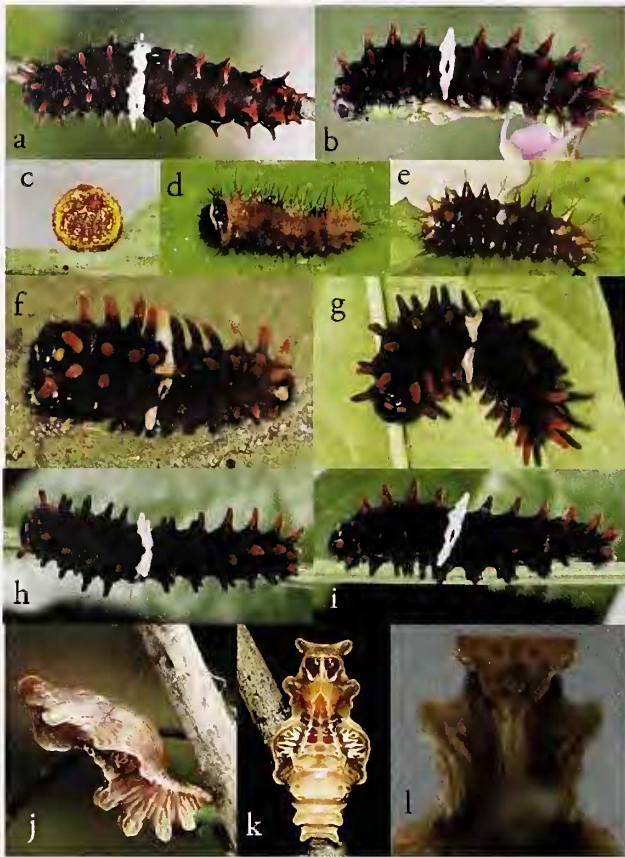


Figure 6. *Pachliopta aristolochiae ceylonica*. **6a:** Larva, fifth instar, dorsal view. **6b:** Larva, fifth instar, lateral view. **6c:** Egg. **6d:** Larva, first instar, newly emerged. **6e:** Larva, first instar, two days old. **6f:** Larva, second instar. **6g:** Larva, third instar. **6h:** Larva, fourth instar, dorsal view. **6i:** Larva, fourth instar, lateral view. **6j:** Pupa, lateral view. **6k:** Pupa dorsal view. **6l:** Pupa, close-up, ventral view.

Talbot (1939) from Indian sources. The current study showed for the first time that the following are larval food plants in Sri Lanka: *Aristolochia indica*, *A. bracteolata* and *Thottea siliquosa* (Aristolochiaceae). The use of *T. siliquosa* was recorded only once in the field and the larva grew slowly and produced a dwarf individual. *A. indica* is widespread over most of the island up to 1000 m asl and is the most extensively used larval food plant. *A. bracteolata* is restricted to dry sandy regions (Jaffna, Mannar, Trincomalee and Batticaloa). *T. siliquosa* is distributed mainly in the wet zone where it grows under dense shade (Dassanayake, 1999).

P. aristolochiae ceylonica is common and distributed over most of the island. The distribution of the three known larval food plants matches the distribution of this species well. It is possible though that *A. ringens*, a naturalized introduction that is found in the central

hills, is also used as a larval food plant though this plant is reported to be poisonous to the larva of *P. hector* (H. D. Jayasinghe, pers. comm.).

Troides darsius (Gray, [1853]). Common Birdwing. Endemic species.

The final instar larva and pupa of *T. darsius* were described by Moore (1880) from Sri Lankan material. This description of the larva agrees with the findings of the current study except for the following points: in *T. darsius*, a) the streak on S7 and S8 is pale pink to ivory ("pale pink" in Moore) and b) the ground color in some individuals is light brown (not just dull purple brown as in Moore) (Figs. 7a, b). In addition, the description of the filaments is not clear and they are re-described here: S3–S14. 1 pair (subdorsal); S3–S5, 1 pair (dorso-lateral); S2–S6, 1 pair (lateral, shorter); S2–S13, 1 pair (subspiracular) and a filament on each proleg (S7–S10). Most of the filaments are white-tipped. The description of the pupa agrees with the findings of the current study except for the following: in *T. darsius*, the pupa shows much greater variation in color: in addition to the pale purplish-ochreous color recorded by Moore (that additionally has lateral orange patches) (Figs. 7c, d), the pupa also may be greenish-gray with golden yellow patches on the dorsum, and shadings in between (Figs. 7e, f).

Additional notes on immature stages: Egg: globular, pink with a rough, discontinuous orange covering, a dark-colored micropyle and distinct orange cement (Fig. 7g). 1st instar: newly hatched larva ate the eggshell, head purplish-brown, abdomen purplish-brown except S11–S14 orange, dorso-lateral filaments with fine black spines on each segment from S2–S14, anterior edge of S2 bordered by yellow (Fig. 7h). 2nd instar: dark purplish-brown, filaments S2–S13, 1 pair (subdorsal, same color as ground color except for those on S8 and S11 which are pinkish with a dark tip); S3–S5, 1 pair (dorsolateral); S2–S14, 1 pair (lateral, those on S7 and S11–S14 whitish); head and legs black (Fig. 7i). 3rd instar: not recorded. 4th instar: same as 5th. Length of mature larva 55 mm. Duration of immature stages (days): Egg (7–8); 1st instar (3); 2nd (4); 3rd (8); 4th & 5th (not recorded); pupation (2); pupa (26); egg-adult (56).

Larval food plants: In Sri Lanka, "*Aristolochia*" was reported by Moore (1880) and "*Aristolochia* and the Betel leaf" by Moore (1901-03) after Tennent (1861). Woodhouse (1949) reported "plants of the family Aristolochiaceae and Betel leaf" after Talbot (1939) who quoted from Moore. Igarashi and Fukuda (2000) stated that *Aristolochia indica* was used. Matsuka (2001) reported seeing larvae, eggs and oviposition on *A. indica* and additionally listed *A. tagala* as a larval food plant but without a reference. Igarashi and Fukuda (2000) further reported that "formerly, the larva of this butterfly has been believed to feed on *Aristolochia tagala*" but without a reference. No other authors have reported *A. tagala* as a larval food plant for this species. The current study confirmed that

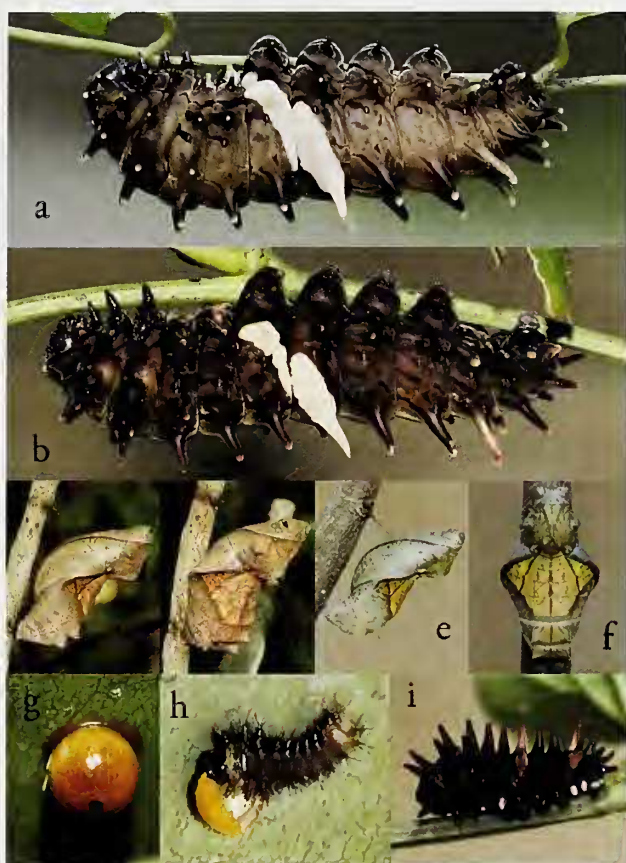


Figure 7. *Troides darsius*. **7a:** Larva, fifth instar, brown form. **7b:** Larva, fifth instar, purplish-brown form. **7c:** Pupa, purplish-ochreous form, lateral view. **7d:** Pupa, purplish-ochreous form, dorso-lateral view. **7e:** Greenish-gray form, lateral view. **7f:** Pupa, greenish-gray form, dorsal view. **7g:** Egg. **7h:** Larva, first instar. **7i:** Larva, second instar.

Aristolochia indica (Aristolochiaceae) is a larval food plant in Sri Lanka. The scientific name of the “betel leaf” plant likely refers to *Piper betle* (Piperaceae). We have not been able to confirm whether or not *Piper betle* is used as a larval food plant. However, it is unlikely because there are no records of any species of the Troidini using any species of Piperaceae. We have not been able to confirm the use of *A. tagala* as a larval food plant. Igarashi and Fukuda (2000) stated that in Moore (1880-81), there is an illustration of *A. tagala* as the food plant. However, the illustration that they refer to is inaccurate—it is little more than a sketch of a branch and what appear to be unopened flower buds. It is unclear on what basis they identified it as *A. tagala*. Further, *A. tagala* does not occur in Sri Lanka (Dassanayake, 1999; Trimen, 1895) though several references (for example, Murugan *et al.*, 2006) claim erroneously that it does.

T. darsius is fairly common and widespread as is its larval food plant, *A. indica*. It is likely that this is the only larval food plant in Sri Lanka. However, the closely related *T. mimos* in India feeds on *Thottea siliquosa* which is also found in Sri Lanka; it is possible that this is used as a food plant in Sri Lanka as well. It is also possible that *T. darsius* might use *A. ringens*, which has been introduced into the central hills where *T. darsius* is also found. The only other native species of *Aristolochia* in Sri Lanka is *A. bracteolata*. It is unlikely that this is used as a larval food plant because it is a low-growing vine found in the hot, dry coastal areas where *T. darsius* is very rarely seen.

Tribe Papilionini

Papilio clytia lankeswara Moore, 1879. Common Mime. Endemic subspecies.

The final instar larva and pupa of *P. clytia lankeswara* were described by Moore (1880) as *Chilasa dissimilis* and *C. lankeswara* from Sri Lankan material. The final instar larva and pupa of *P. clytia* were described by Moore (1903-1905), Davidson and Aitken (1890) and Bell (1912a) from Indian material. Woodhouse (1949) quoted from Talbot (1939) who quoted from Bell (1912a). These descriptions of the larva agree with the findings of the current study except for the following: in *P. clytia lankeswara*, a) the ground color of the abdomen varies from almost black to dark grayish-green to, rarely, light blue, and is studded with black spots; b) the larvae with a blue ground color have pink to white bands while the others have yellow bands as described. Further, the filaments and crimson spots are not well described and are described here: filaments black; S3 & S4, 1 pair (subdorsal, short); S3–S13, 1 pair (just outside this, still subdorsal); S3–S5, 1 pair (lateral); and S5 & S6, 1 pair (subspiracular, crimson). Crimson spots: laterally, single spot on each of S3–S6 and S8–S10; spot (variable in size) at base of each filament on the inner margin on S3–S11; single subspiracular spot on S5–S12. What Moore describes as the “posterior band” is a very wide subdorsal band on S11–S14 (Figs. 8a-c). These descriptions of the pupa agree with the findings of the current study except for the following: in *P. clytia lankeswara*, the pupa varies from light brown to dark grayish-brown (Figs. 8d, e).

Additional notes on immature stages: Egg: smooth, spherical, light green with a discontinuous rough orange coating (Fig. 8f). 1st instar: head black, abdomen more or less square in section, broadest at S2 tapering to S14; ground color black; brown dorsal patch on S2–S4, dorsal white patches on S7, S8, S12 and S13; dorsal row of filaments armed with spines on S2–S13; those on S7, S8, S12 and S13 white; filaments on S2 more prominent than the rest (Fig. 8g). 2nd instar: similar to the 1st, ground color shades of glossy reddish-brown; abdomen broadest at S4; spines on filaments much

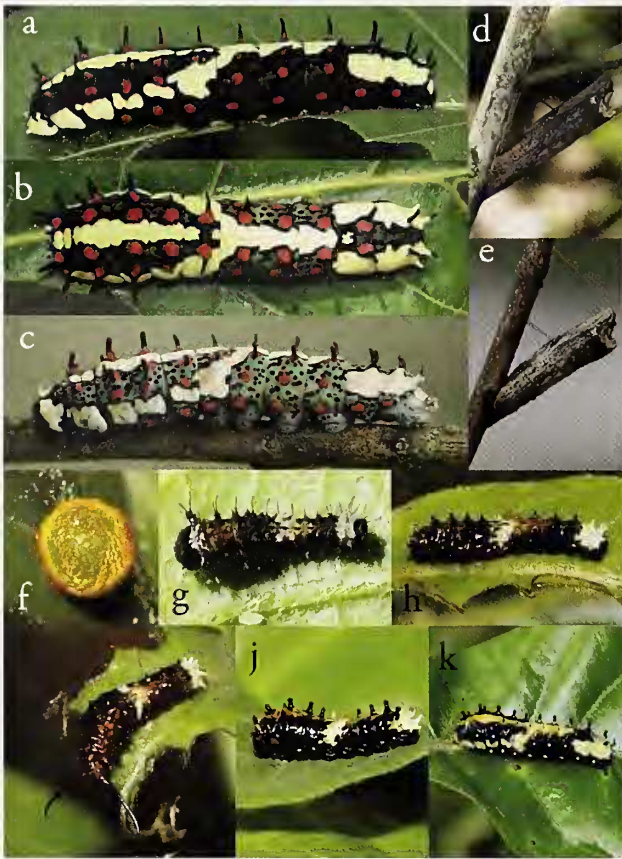


Figure 8. *Papilio clytia lankeswara*. **8a:** Larva, fifth instar, dorso-lateral view. **8b:** Larva, fifth instar, dorsal view. **8c:** Larva fifth instar, blue colored form. **8d:** Pupa, dark brown. **8e:** Pupa, light brown. **8f:** Egg. **8g:** Larva, first instar. **8h:** Larva, second instar. **8i:** Larva, second instar, osmeterium everted. **8j:** Larva, third instar. **8k:** Larva, fourth instar.

reduced; dorsal and dorso-lateral white markings confined to S7/S8 and S12/S13 (Figs. 8h, i). 3rd instar: Ground color black with a bright orange irregular dorsal band; white patches similar to those of 2nd instar. Light-blue subspiracular spots S5–S12 (Fig. 8j). 4th instar: similar to 3rd but dorsal band cream-colored (Fig. 8k). Length of mature larva 38–43 mm. Duration of immature stages (days): Egg (2–3); 1st instar (3–4); 2nd (not recorded); 3rd (2–3); 4th (1–2); 5th (4–5); pupation (2); pupa (11–18 though some individuals remained in the pupal stage for 2 months or more); egg–adult (25–34, up to 80).

Larval food plants: In Sri Lanka, Moore (1880) reported “*Tetranthera*” [now *Litsea*] as the larval food plant and also quoted from Mackwood who said it feeds on “cinnamon.” Woodhouse (1949) quoting from Talbot (1939) after Bell (1912a) from Indian sources wrote “various Lauraceae (laurels), and various species of *Cinnamomum*, *Nauclea cadamba* [now *Neolamarckia cadamba*], *Litsea sebifera* [now *Litsea glutinosa*].” d’Abrera (1998) reported that the larvae were “easy to rear on camphor laurel (Sinh[alese]: kapuru)” [possibly referring to *Cinnamomum camphor*

or *Cinnamomum capparum-coronde*]. The current study confirmed *Litsea glutinosa* (Lauraceae) as the most widely used larval food plant in Sri Lanka. It also showed for the first time that *Cinnamomum verum* (Lauraceae) is a larval food plant in Sri Lanka, but the only larva on this plant grew slowly. We have not been able to confirm the use of *C. capparum-coronde* which is an endemic species found in the wet zone or *C. camphora* which is an introduced plant (Lauraceae). *N. cadamba* (Rubiaceae) is not likely to be a larval food plant: Moore (1903-05) seems to be the source of this record and none of the usual authors (Davidson & Aitken, 1890; Bell, 1912a) mentioned it. Further this species has not been recorded in Sri Lanka (Dassanayake, 1987).

Litsea glutinosa is very common in the forested and non-forested areas in the wet, dry and intermediate zones to 1000 m asl. In non-forested areas, the plants are frequently cut which causes them to flush a new set of leaves which are ideal egg-laying sites for *P. clytia lankeswara*. *Cinnamomum verum* is found in the wet low country to 700 m asl (Dassanayake, 1995).

P. clytia lankeswara is common all over the island at lower elevations to about 700 m asl. Though the distribution of the known larval food plants matches that of *P. clytia lankeswara*, it is possible that there are other larval food plants since this species is so common and so widely distributed.

Papilio polymnestor parinda (Moore, [1881]). Blue Mormon. Endemic subspecies.

The final instar larva and pupa of *P. polymnestor parinda* were described by Moore (1880) from Sri Lankan material. The larva and pupa of *P. polymnestor* were described very briefly by Davidson and Aitken (1890) and in detail by Bell (1912a) from Indian material. Woodhouse (1949) quoted Talbot (1939) (after Moore (1880) and Bell (1912a)) and from Tunnard and Fryer (1911) both of whose works were based on Sri Lankan material. These descriptions of the larva agree with the findings of the current study but in addition, after the 4th molt, for a day or two, the larva is a light bluish-green with yellow markings laterally (Figs. 9a, b). These descriptions of the pupa agree with the findings of the current study except for the following: in *P. polymnestor parinda*, the color of the pupa varies from green, to brown, to brown mottled with green (Figs. 9c-e).

Additional notes on immature stages: Egg: round and light yellow (as per Tunnard in Woodhouse 1949). 1st instar: head black, dark brown at the margin, covered with short black bristles; abdomen more or less square in section, dark greenish-brown with a diamond-shaped white dorsal patch from S6–S11; S2 with 1 pair of long anterior lateral filaments and a smaller pair posteriorly, a white band between the filaments; S3 and S4

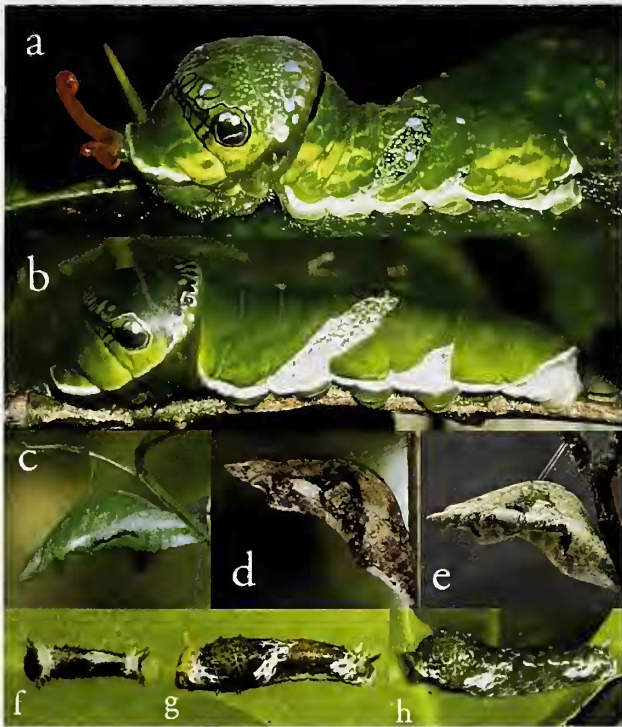


Figure 9. *Papilio polymnestor parinda*. **9a:** Larva, fifth instar, after molt, osmeterium everted. **9b:** Larva, fifth instar, late in instar. **9c:** Pupa, green. **9d:** Pupa, brown. **9e:** Pupa, brown with green. **9f:** Larva, first instar. **9g:** Larva, third instar. **9h:** Larva, fourth instar.

with shorter, black filaments with short hairs, 3 pairs (subdorsal, lateral, subspiracular); S5–S11, filaments black or dark brown, 2 pairs (subdorsal, subspiracular), progressively shorter posteriorly; S12 with a pair of white subdorsal filaments and entire segment with a white transverse band; S13 with 1 pair long, light brown filaments subdorsal (Fig. 9f). 2nd instar: not recorded. 3rd instar: head light greenish-brown, abdomen brownish-green, widest at S4 and circular in transverse section; white irregular patch ascending obliquely to the dorsal line on S4–S6; a similar white irregular patch from S11–S13, white irregular patch on S2 and S3 confined to the lateral margin. Filaments highly reduced except those on S2, S12 and S13; those on S2 are the most prominent and light-orange in color including the area behind them; S3 and S4 with knobby, short filaments, 1 pair subdorsally, 2 pairs laterally; S5 with similar knobby filaments but without the lowest pair of lateral filaments; S12 and S13 filaments white and well-developed but shorter than on S2 (Fig. 9g). 4th instar: head yellowish-green, abdomen brownish-green and minutely speckled with white spots; white patches on abdomen similar to 3rd instar; filaments greatly reduced, S12 carries a very small pair of subdorsal filaments and S13 a larger pair, both sets white; 2 pairs of light blue lateral spots on S4, S5 and S8; usually one pair on S9; S6–S14 with a white band along the margins below the spiracular line (Fig. 9h). Duration of immature stages (days): Egg (4–9); 1st–5th instar (not recorded); pupa (11–15); egg–adult (40–44; except for 1 ♀ – 33). In the higher hills (1100 m asl), where the temperatures are much cooler, Tunnard (Woodhouse 1949) recorded much longer durations for the immature stages.

Larval food plants: In Sri Lanka, Moore (1880)

listed "*Citrus decumana* [now *C. grandis*] &c"; Tunnard (Woodhouse, 1949) listed "orange tree" and Fryer (1911) listed "Rutaceae....and *Citrus*." The current study confirmed *Citrus grandis* as a larval food plant in Sri Lanka. It also showed for the first time that the following are larval food plants in Sri Lanka: *Citrus reticulata*, *C. aurantifolia* and *C. sinensis* in disturbed and cultivated areas, and *Atalantia ceylanica*, *A. monophylla* and *Paramignya monophylla* in the forests of the dry and intermediate zones (all Rutaceae).

Citrus grandis, *C. reticulata*, *C. aurantifolia* and *C. sinensis* are commonly cultivated around the island. *Atalantia ceylanica* is found in forests of the intermediate and dry zones (Rattota, Yala, Knuckles). *A. monophylla* is found on rocky coasts and towards the interior in dry areas (Wilpattu, Uma Oya, Yala). *Paramignya monophylla* is widespread in the drier areas at low and moderate altitudes (Medawachchiya, Yala, Trincomalee) but also in the wetter areas (Rambode, Kandy) (Dassanayake, 1985).

P. polymnestor parinda is found throughout the year, all over the island to about 1000 m asl in all zones. The distributions of the known larval food plants match that of *P. polymnestor parinda*. However, other Rutaceae may be used.

Papilio crino Fabricius, 1793. Common Banded Peacock.

The final instar larva and pupa of *P. crino* were described briefly by Moore (1880) from a pencil sketch of a specimen found in Sri Lanka. Both Bell (1912b) and Woodhouse (1949) quoted from Moore (1880). These descriptions are so brief that we describe all instars and the pupa in detail.

Additional notes on immature stages: Egg: spherical, smooth, pale greenish-yellow (Fig. 10a). 1st instar: newly emerged larva ate most of the eggshell, head pale brownish-gray with moderately long hairs laterally; abdomen more or less square in section, broadest at S2, ground color grayish-white, gray dorsally; dorsal line grayish-green to brownish; dorso-lateral band black to dark brown; pair of dorso-lateral filaments armed with spines on S2–S13; filaments on S2 and S13 longest, brown; S2 with an additional pair of short white filaments posterior to the brown pair and with a white dorsal patch behind the filaments; filaments on S3–S10 progressively smaller and greenish-brown; filaments on S11 longer and greenish-brown; those on S12 longer and white; filaments with spines from S2–S4 laterally, filaments about as long as those on S12; a black lateral band from S4–S10; dark brown to black below spiracular line (Fig. 10b). 2nd instar: similar to the 1st; lateral filaments on S3 and S4 more prominent, those on the dorso-lateral band reduced in size; S2–S5 more rounded and broadest at S4; S3 and S4 grayish-green dorsally, this color extending faintly along the dorsal line and along the side, enclosing the black bands (Fig. 10c). 3rd instar: similar to the 2nd but much greener overall with dorso-lateral filaments on S3–S12 barely visible; lateral filaments on S3 and S4 small; filaments on S2, S12 and S13 still prominent; larva turns darker green toward the end of the instar and the black lateral line becomes faint (Figs. 10d, e). 4th instar: similar to 3rd, ground color light grayish-green with faint black lateral



Figure 10. *Papilio crino*. 10a: Egg. 10b: Larva, first instar. 10c: Larva, second instar with molt. 10d: Larva, third instar, dorsal view. 10e: Larva, third instar, lateral view. 10f: Larva fourth instar, lateral view. 10g: Larva, fourth instar, close up of face. 10h: Larva, fourth instar, green form. 10i: Larva, fifth instar, right after molt, black mark on S5 visible. 10j: Larva, fifth instar. 10k: Pupa.

line from S7–S12 that is flanked on either side by cream-colored line that extends to S2; rather indistinct cream-colored subdorsal line; head grayish-green with faint white bands on adfrontal area and side of clypeus (Figs. 10f, g); towards the end of this instar, some individuals lose the cream-colored and black bands i.e. they become all green speckled with light cream spots (Fig. 10h). 5th instar: head blue-green; abdomen paler green speckled with minute cream-colored spots; S2–S5 convex and shield-like dorsally with a white border; S4 with a prominent lateral white spot with two black transverse bands; S6–S12 with a prominent white band at the base of each segment above the prolegs; S12 with greatly reduced subdorsal amber-colored filaments; spiracles slit-like, grayish, small; black slit-like mark dorso-laterally at the posterior end of S5, which is evident only when the abdomen is stretched (Figs. 10i, j). Pupa: green, with distinct cream colored lateral and dorsal lines, series of subdorsal and lateral black spots from S5–S12; female pupae distinctly broader and more rounder than those of males; well concealed among the leaves (Fig. 10k). Length of 2nd instar (11 mm); length of mature larva 30–40 mm. Duration of immature stages (days): Egg (3–5); 1st instar (3–6); 2nd (2–3); 3rd (3–5); 4th (4–5); 5th (6–9); pupation (1); pupa (11); egg–adult (32–38).

Larval food plants: In Sri Lanka, *Chloroxylon swietenia* was recorded by Moore (1880) based on a report by J. Pole. d'Abbrera (1998) also reported *C. swietenia* based on a personal communication

from P. B. Karunaratne in Sri Lanka. The current study showed for the first time that the following are larval food plants in Sri Lanka: *Toddalia asiatica* and *Clausena indica* (Rutaceae). It also confirmed *Chloroxylon swietenia* (Rutaceae) as a larval food plant in Sri Lanka.

Chloroxylon swietenia is fairly common in the dry deciduous forests of the dry and intermediate zones at lower elevations and very sparse in the wet zone. *Toddalia asiatica* is more widespread: it is rather common in montane forests (Pussellawa, Hakgala, Horton plains) and quite common in the dry and intermediate zones (Dambulla, Wilpattu, Jaffna, and Trincomalee). *Clausena indica* is locally common in the dry and intermediate zones (Kurunegala, Hunnasgiriya, Dambulla, Mannar, Jaffna, Wellawaya) (Dassanayake, 1985).

P. crino is a common species, found all over the island up to about 1000 m asl. The distributions of the known larval food plants match that of *P. crino* well. *C. swietenia* is the preferred larval food plant in the dry and intermediate zones, despite the availability of *Toddalia asiatica* and *Clausena indica*. In the wet zone, where *C. swietenia* is very rare, *Toddalia asiatica* is used.

Papilio helenus mooreanus Rothschild, 1895. Red Helen. Endemic subspecies.

The final instar larva and pupa of *P. helenus mooreanus* (as *Charus helenus*) were described briefly by Moore (1880) from Sri Lankan material. The larva and pupa of *P. helenus daksha* were described briefly by Davidson and Aitken (1890), and in detail by Bell (1912a) from Indian material. Woodhouse (1949) quoted from Moore (1880) and from Tunnard in Sri Lanka. The descriptions of the larva (Figs. 11a–d) and pupa (Figs. 11e, f) in Moore and by Tunnard agree with the findings of the current study.

Additional notes on immature stages: Egg: spherical, pale yellow (Fig. 11g). 1st instar: newly hatched larva ate eggshell, description not recorded. 2nd instar: not recorded. 3rd instar: bird-dropping type, head reddish-brown; abdomen dark orange-brown with white transverse band mottled with brown on apical one-third of S6, all of S7 and basal one-third of S8; S11–S13 white; S2 dorsally light brown. Filaments (very small except those on S2, color same as ground color except where noted): S2, 1 pair (subdorsal); S3, 2 pairs (subdorsal and lateral); S4, 3 pairs (dorsal, subdorsal and lateral); S5, 2 pairs (subdorsal and lateral, lateral filaments posterior to subdorsal ones); S6–S11, 1 pair each (subdorsal, brown); S12 & S13, 1 pair each (subdorsal, white) (Figs. 11h, i). 4th instar: bird-dropping type; two color forms: form 1—green & white; form 2—amber & white. Form 1—head green, ground color white, S2 yellow anteriorly with 2 small filaments of similar color, S3 with 2 pairs of dorsal and dorso-lateral raised yellowish spots; S4 with 6 spots (the 4 outer ones with a pale blue spot inwardly); S5 with 6 spots but the two center ones are displaced anteriorly and outer 4 spots with pale blue inwardly; S3–S5 convex and shield-like dorsally; S7–S9 with one oblique

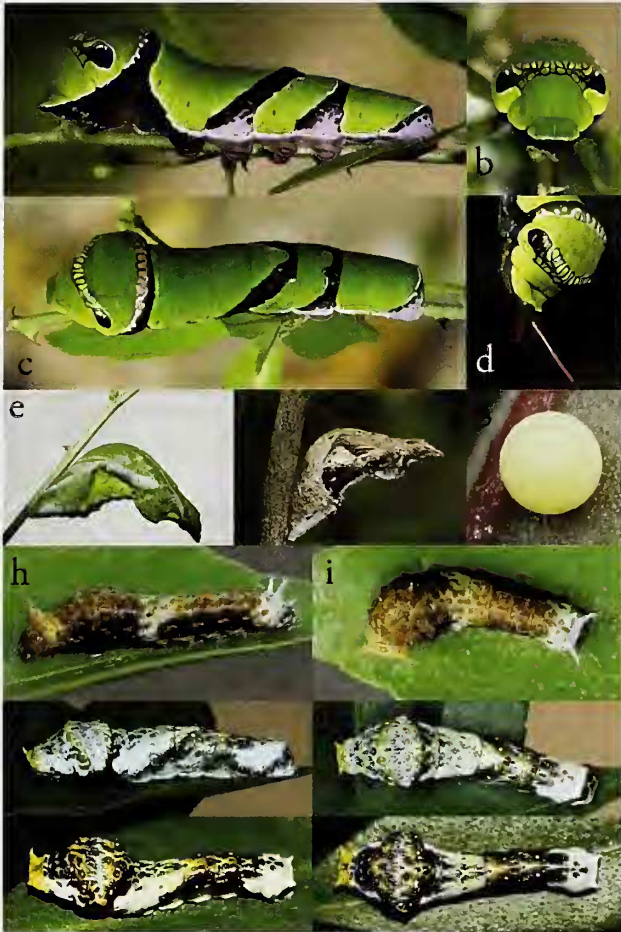


Figure 11. *Papilio helenus mooreanus*. **11a:** Larva, fifth instar, lateral view. **11b:** Larva, fifth instar, close up of face. **11c:** Larva, fifth instar, dorsal view. **11d:** Larva, fifth instar, osmeterium everted. **11e:** Pupa, green form. **11f:** Pupa, brown form. **11g:** Egg. **11h:** Larva, third instar, dorso-lateral view. **11i:** Larva, third instar, dorsal view. **11j:** Larva, fourth instar, green and white form, lateral. **11k:** Larva, fourth instar, green and white form, dorsal. **11l:** Larva, fourth instar, green, white and amber form, lateral. **11m:** Larva, fourth instar, green, white and amber form, dorsal.

broad irregular greenish-brown band, S10 with shorter oblique broad irregular greenish-brown band; S9 with 4 slightly raised, greenish-yellow, spots (2 subdorsal and 2 lateral), each spot with a pale blue spot inwardly; S10 with 2 subdorsal raised yellowish spots, each with a pale blue spot inwardly; S13 with small white dorsal filaments; abdomen narrowest at S11, broadest at S5, widens from S1–S5, narrows from S5–S11 and then broadens again (Figs. 11j, k). Form 2—ground color white, markings similar but pale yellow spots on S3–S5 amber-colored (still with pale blue spots); bands on S7–S10 amber-colored; S2 bright yellow (Figs. 11l, m). Length of mature larva 54 mm. Duration of immature stages (days): Egg (4); 1st instar (3); 2nd (6); 3rd (3); 4th & 5th (not recorded); pupation (1); pupa (16–21); egg–adult (45–50). In the higher hills (1100 m asl), Tunnard (Woodhouse, 1949) reported longer durations for all stages.

Larval food plants: In Sri Lanka, “Rutaceae... and *Citrus*” were reported by Fryer (1911). The current study showed for the first time that *Toddalia asiatica* (Rutaceae) is a larval food plant in Sri Lanka. There are reports of it feeding on *Citrus sinensis* (Rutaceae) in captivity but no records of it ovipositing on this plant in the field.

Toddalia asiatica is quite widespread: it is rather common in montane forests (Pussellawa, Hakgala, Horton Plains) and quite common in the dry and intermediate zones (Dambulla, Wilpattu, Jaffna, and Trincomalee) (Dassanayake, 1985). *P. helenus mooreanus* is not uncommon in submontane and montane regions of the wet and intermediate zones and on the southern slopes to 500 m asl. The distribution of *Toddalia asiatica* matches that of *P. helenus mooreanus* well but there may be other plants used.

Papilio polytes romulus Cramer, [1775]. Common Mormon.

The final instar larva and pupa of *P. polytes romulus* were described by Moore (1880) and by Tunnard (Woodhouse, 1949) from Sri Lankan material (Fig. 12a-c). The larva and pupa of *P. polytes* were described briefly by Davidson and Aitken (1890) and Davidson *et al.* (1897), and in detail by Moore (1901-1903) and Bell (1912a) from Indian material. Woodhouse (1949) quoted from Talbot (1939) (who quoted from Bell (1912a) and Jordan (1909)) from Indian material and from Tunnard from Sri Lankan material. The 4th instar of *P. polytes* was described by Moore (1901-1903). These descriptions of the larva agree with the results of the current study except for the following point: in *P. polytes romulus*, some individuals in the 4th instar have a brown head (Fig. 12d). These descriptions of the pupa agree with the results of the current study except that the pupa can be green, or brown mottled with gray (Figs. 12e, f).

Additional notes on immature stages: Egg: spherical, pale yellow. 1st instar: head light brown; abdomen greenish-brown; diffuse light-yellow broad dorsal stripe S3–S11; S2 pale-yellow; filaments: S2, 2 pairs (anterior pair, lateral, long, brown, posterior pair subdorsal, small, white); S3 and S4, 3 pairs (subdorsal, lateral, subspiracular, shorter, light brown, with fine hairs); S5–S11, 2 pairs (subdorsal, lateral (light brown)); S12, 1 pair (subdorsal, white); S13, 1 pair (subdorsal, light brown and white) (Fig. 12g). 2nd instar: almost identical to 4th (Fig. 12h). 3rd instar: almost identical to 4th (Fig. 12i). Duration of immature stages (days): Egg (1–4); 1st–4th instar (not recorded); 5th (5); pupation (1); pupa (10–12); egg–adult (34).

Larval food plants: In Sri Lanka, Woodhouse (1949) reported *Toddalia asiatica* and “all types of *Citrus* trees” after Tunnard, and *Murraya koenigii*. The current study confirmed the following as larval food plants in Sri Lanka: *Toddalia asiatica*, *Murraya*

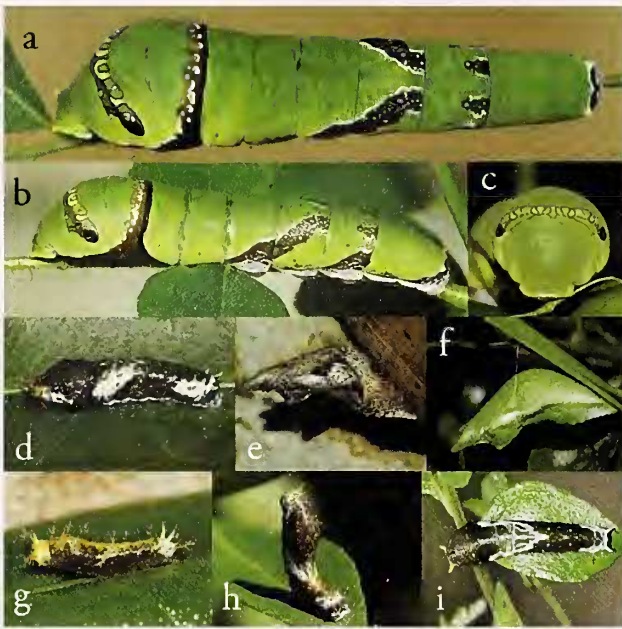


Figure 12. *Papilio polytes romulus*. **12a:** Larva, fifth instar, dorsal view. **12b:** Larva, fifth instar, lateral view. **12c:** Larva, fifth instar, close up of face. **12d:** Larva, fourth instar. **12e:** Larva, pupa, brown form. **12f:** Larva, pupa, green form. **12g:** Larva, first instar. **12h:** Larva, second instar. **12i:** Larva, third instar.

koenigii, *Citrus sinensis*, *Citrus aurantifolia* and *Citrus limon* (Rutaceae). It also showed for the first time that the following are larval food plants in Sri Lanka: *Micromelum minutum* (H. D. Jayasinghe, pers. comm.), *Atalantia ceylanica*, *Pleiospermium alatum*, and *Glycosmis pentaphylla* (Rutaceae).

Toddalia asiatica is quite widespread: it is rather common in montane forests (Pussellawa, Hakgala, Horton plains) and in the dry and intermediate zones (Dambulla, Wilpattu, Jaffna, and Trincomalee) (Dassanayake, 1985). *Atalantia ceylanica* is found in forests of the intermediate and dry zones (Rattota, Yala, Knuckles). *Pleiospermium alatum* is common in the low country dry zone. *Glycosmis pentaphylla* is fairly common in the low country especially in the dry and intermediate zones. *Micromelum minutum* is found in the low country, especially in the dry and intermediate zones. *Murraya koenigii*, although widely cultivated around the island, is restricted to the low country, especially in the dry and intermediate zones. *Citrus sinensis*, *Citrus aurantifolia* and *Citrus limon* are widely cultivated around the island.

P. polytes romulus is widely distributed over all the island, including up to the highest hills. The distributions of the known larval food plants match the distribution of *P. polytes romulus* well. However,

other species of Rutaceae, such as *Glycosmis angustifolia*, may also be larval food plants.

Papilio demoleus demoleus Linnaeus, 1758. Lime Butterfly.

The final instar larva and pupa of *P. demoleus* were described briefly by Moore (1880) and of *P. d. demoleus* by Tunnard (Woodhouse 1949) from Sri Lankan material. The larva and pupa of *P. demoleus* were described in detail by Bell (1911) from Indian material. Woodhouse (1949) also quotes from Talbot (1939) who quoted from Bell (1911) reporting from India. These descriptions of the larva agree with the findings of the current study except for the following points: in *P. d. demoleus*, a) Moore (1880) described “dorsal bands” on S3 and S4 but these are more correctly described as transverse bands and they are on S4 and S5. Further he describes the bands as yellow but in the current study, they were found to be white, brown, black or dark orange or absent or reduced to spots; b) Moore (1880) described a pale lateral streak on S8 and S9 but in the current study, the lateral streak is either entirely absent or reduced in varying degrees and is colored white, or brown or a mottled mix of white and brown; c) Moore (1880) described an upright streak on S10 but in the current study, the streak is either entirely absent or reduced in varying degrees and is colored white, or brown, or a mottled mix of white and brown; d) the filaments on S2 and S13 are brown to reddish-brown and the tips are a lighter shade (this feature distinguishes the larva of *P. d. demoleus* from that of *P. polytes romulus*); e) “the pale yellow lower lateral line” described by Moore (1880) is sometimes white or can be absent, replaced by a series of subdorsal black spots from S9–S12; f). Moore (1880) described the ground color as green but in the current study, the ground color varied from light green to yellow-green and to blue-green. Of all the Papilionidae in Sri Lanka, the final instar of *P. d. demoleus* is the most variable in color and markings (Figs. 13a-h), a fact that has not been noted by any previous authors. These descriptions of the pupa agree with the findings of the current study (Fig. 13i).

Additional notes on immature stages: Egg: pale yellow and smooth (Fig. 13j). 1st instar larva: newly hatched larva ate all the eggshell, head light brown, ground color dark brown to black, S2 light brown, S7 and S8 with a light yellowish dorsal patch that extends laterally, S12–S14 dark amber-colored, S2–S13 with dark brown filaments (except where noted), 1 pair subdorsal and 1 pair spiracular, each of which has many black spines, S2 and S13 with the longest, subdorsal, brown filaments, S7 and S8 with yellowish subdorsal filaments, spiracular filaments almost black and very small (Fig. 13k); next day, abdomen lighter colored and mottled with white especially on S7 and S8. 2nd instar: agrees with the description of Chaumette reporting from Lucknow in

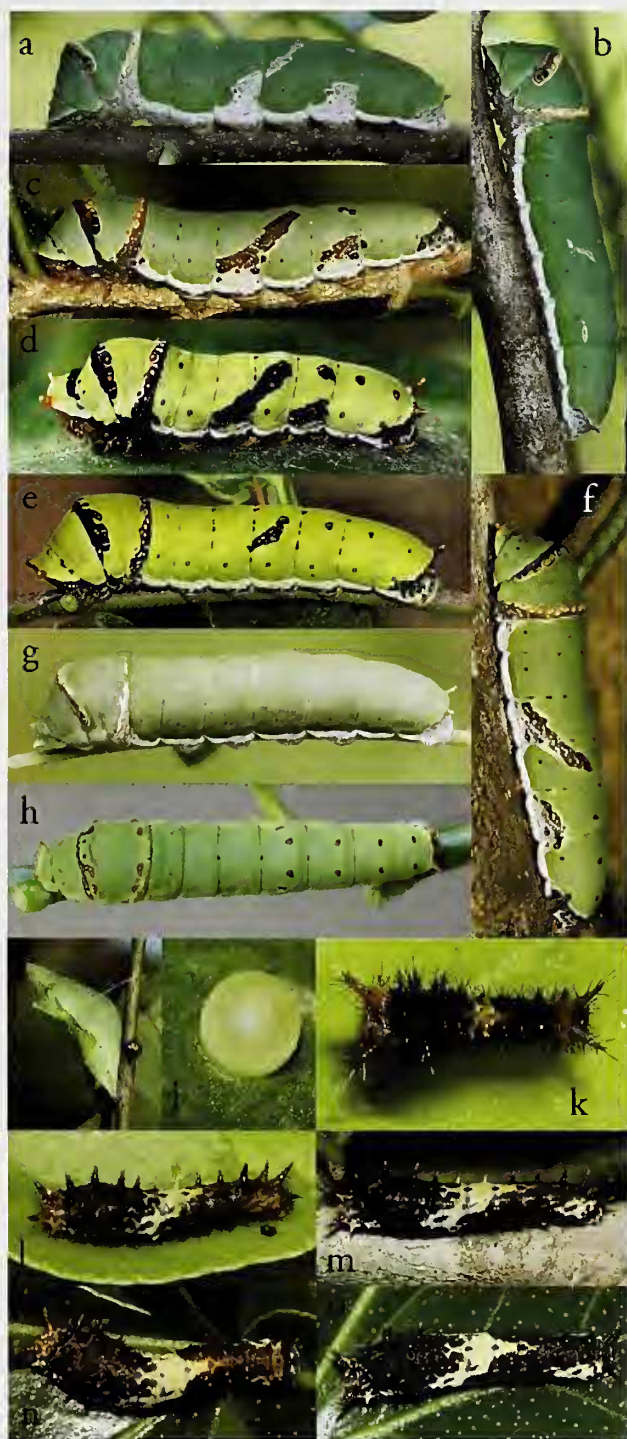


Figure 13. *Papilio demoleus demoleus*. 13a: Larva, fifth instar. 13b: Larva, fifth instar. 13c: Larva, fifth instar. 13d: Larva, fifth instar. 13e: Larva, fifth instar. 13f: Larva, fifth instar. 13g: Larva, fifth instar. 13h: Larva, fifth instar. 13i: Pupa, lateral view. 13j: Egg. 13k: Larva, first instar. 13l: Larva, second instar. 13m: Larva, third instar. 13n: Larva third instar. 13o: Fourth instar, dorsal view.

India (Moore, 1901-1903) except that the ground color is dark brown to black not pale olive-green (Fig. 13l). 3rd instar: same as the 2nd (Figs. 13m, n). 4th instar: agrees with the description of Chaumette except that the ground color is dark brown (not green or bright olive); there is no lateral line over the legs, S3 and S4 have no orange markings, the v-shaped patch on S7 and S8 is whitish and is united on the back, and S9 has only a white mid-dorsal patch (Fig. 13o). Length (mm) of 1st instar (4); 2nd (8); 3rd (15); 4th (22). Duration of immature stages (days): 1st instar (2); 2nd (1); 3rd (2); 4th (2-3); 5th (5); pupation (1); pupa (10).

Larval food plants: In Sri Lanka, Tunnard (Woodhouse, 1949) reported "lemon (*Citrus [limon]*)". Woodhouse (1949) reported "Aegle marmelos, orange [*Citrus sinensis*], pomelo [*Citrus grandis*], lime [*Citrus aurantifolia*], *Zizyphus [sic] jujuba* [now *Zizyphus mauritiana*], *Glycosmis pentaphylla*" after de Nicéville (no reference) and "also known to be *Feronia elephantum*" [now *Limonia acidissima*]. The current study showed for the first time that *Chloroxylon swietenia* (Rutaceae) and *Cullen corylifolium* (Fabaceae) are larval food plants in Sri Lanka. It also confirmed the following as larval food plants in Sri Lanka: *Citrus aurantifolia*, *Limonia acidissima*, *Citrus limon*, *Citrus sinensis* and *Aegle marmelos*. We have not observed the use of *Glycosmis pentaphylla*, *Zizyphus mauritiana* and *Citrus grandis* as larval food plants. It is unlikely that *Zizyphus mauritiana* (Rhamnaceae) is used: it is a common plant and so likely to have been recorded if used. *Glycosmis pentaphylla* is also a common plant whose use has not been recorded. *Citrus grandis*, which is cultivated, is a possible larval food plant.

Chloroxylon swietenia is fairly common in the dry deciduous forests of the dry and intermediate zones at lower elevations. *Limonia acidissima* is common in the dry zone though lately it has been cultivated in the intermediate and wet zones as well. These two plants are the preferred larval food plants in the dry and intermediate zones. *Cullen corylifolium* is common in the arid zone but found only sparingly in the dry zone. *Citrus limon*, *Citrus sinensis* and *Aegle marmelos* are found only in cultivation, largely in the dry and intermediate zones but also in the wet zone, where the cultivated *Citrus* species are the preferred larval food plants.

P. d. demoleus is widely distributed and common in intermediate, dry and arid zones, but is uncommon in the wet zone. The distributions of the known larval food plants match the distribution of *P. d. demoleus* well but there may be other larval food plants as well.

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NOTE ADDED IN PROOF

Pachliopta jophon. Ceylon Rose.

We were finally able to raise the larva of *P. jophon* to the pupal stage (Fig. 14a-c). It is similar to that of *P. hector* and *P. aristolochiae ceylonica* but can be distinguished by the following: the frontoclypeus is invaginated dorsally at the centre, the edges are rounded and point downwards; the dorsal ridge on the mesothorax divides to form a bell-shaped ridge; the prothorax has one pair of large rectangular red spots bounded by white; it is a more slender pupa.

Graphium nomius nomius. Spot swordtail.

Eggs and larvae were collected by S. Sanjeeva and raised to the adult stage. The description by Bell (1912) of the first instar agrees with the



Figure 14. *Pachliopta jophon*. 14a. Pupa, lateral view. 14b. Pupa, dorsal view. 14c. Pupa, ventral view, close-up of head area.

results of this study. The description of the final instar larva by Davidson and Aitken (1890), by Bell (1912) and by Jordan (1909) as quoted in Talbot (1939) differ somewhat from the findings of this

study. These references describe the larva as black, banded on the sides with narrow white stripes except for the first 3 or 4 segments, which are rusty-red, and sometimes the larva is entirely green. We did not encounter a larva of this description. In the current study, two color forms of the final instar larva were encountered: a green form and a brown form (Figs. 15a–c). The green form has a green ground color, a white supraspiracular line from S2–S14 that has an orange spot at the centre of the line at the centre of each segment, some orange spots have a tinge of red; ventral and lateral margins of S14 are dark reddish-maroon; S4 reddish-brown dorsally above the supraspiracular line; S2–S4, S14 with 1 pair of black spines each, very short and sharp; spiracles pale greenish-yellow bounded by a black ring; S2 dorsally greenish-orange; dorsum with a ferruginous cast on all segments. The brown form has a light brown ground color above the orange supraspiracular line and light green below; S5–S14 with 2 transverse white bands per segment above the supraspiracular line, S4 black dorsally; white subspiracular line and ground color below this is light greenish-yellow. The descriptions of the pupa agree with the results of the current study (Fig. 15d). Though the larva was raised in the lab, it migrated to the base of the container and pupated under a dried leaf so it is likely that in the wild it pupates under stones and in crevices as described by earlier authors. The larval food plant in Sri Lanka is confirmed to be *Milium tomentosum* (Annonaceae).



Figure 15. *Graphium nomius nomius*. **15a.** Larva, final instar, green form, lateral view. **15b.** Larva, final instar, green form, dorsal view. **15c.** Larva, final instar, brown form, lateral view. **15d.** Pupa, dorso-lateral view. Photographs 15a–c by S. Sanjeeva.